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"Medicinal Mushroom: Bioactive Compound and Their Therapeutic Properties"

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Abstract: For decades, mushrooms have played a significant role in traditional medicine across numerous cultures. The use of medicinal mushrooms has a long history in India, where their therapeutic benefits were highly regarded. People have been using mushrooms for food and medicine. More and more people are realizing that eating a healthy diet helps to maintain excellent health, which lowers the risk of various diseases by controlling and modulating several bodily functions. Large portions of conventional knowledge about the medical effects of mushrooms due to their antifungal, antibacterial, antioxidant, and antiviral qualities in addition to their usage as functional foods are supported by contemporary pharmacological research. This page summarizes the various health benefits that mushrooms offer to people in the form of proteins, carbohydrates, lipids, vitamins, minerals, food, and medications. Researchers will get fresh insight from the material provided, enabling them to transition Pleurotus species from functional food to holistic mushroom medicine.

Keywords: Mushrooms, Medicinal properties -Antioxidant, Anticancer, Antifungal, Anti-Inflammatory, Antiviral.

Introduction:

The ancient times, mushrooms have been regarded as "the ultimate health food" and utilized in traditional medicine all throughout the world. There are between 14,000 and 22,000 species of mushrooms, although the true number could be substantially higher due to species non-description and non-differentiation based on overlapping physical characteristics although more than 2000 types of mushrooms are edible, only around 12 are farmed for commercial purposes, and some are extremely toxic when eaten [3]. The two main causes of the rising global incidence of disease are inadequate nutrition brought on by the modern lifestyle and an average lifespan growth. A variety of illnesses, including metabolic disease, heart disease, severe neurological disorders like Alzheimer's and Parkinson's, accelerated aging, and some cancers, are brought on by oxidative stress, which is brought on by an unbalanced metabolism and an excess of reactive oxygen species (ROS). In addition to being produced internally by the body, ROS can also be produced externally by a variety of agents, including ionizing radiation, UV light, chemotherapy, inflammatory cytokines, and environmental pollutants. In today's modern culture, breathing in harmful chemicals from the surroundings has become inevitable [4]. Mushrooms are a valuable dietary source. They are eaten for their significant nutritional benefits in addition to their natural flavour and taste. Depending on the species' needs for growth, the nutritional content varies. The water content of mushrooms ranges from 93% to 95%, while that of fresh vegetables and beef is just 70% and 92%, respectively. Additionally, on a dry weight basis, they include 10% ash, 56% carbohydrates, 30% protein, 2% fat, and important minerals like iron, potassium, phosphorus, calcium, and copper. They are also a good source of vitamin D and B [5]. Most of the traditional knowledge about mushrooms comes from Far East, China, Japan, Korea and the east

of Russia. However, mushrooms represent a major yet largely untapped source of pharmaceutical products. Many pharmaceutical substances with unique properties were recently extracted from mushrooms and made their way all over the world. Some of the most recently isolated and identified compounds from medicinal mushrooms have shown promising immunomodulatory, antitumor, cardioprotective, antiviral, antibacterial, antiparasitic, hepatoprotective, and antidiabetic properties [6].

Currently, studies are conducted to assess the nutritional value, acceptability, and pharmacological qualities of mushrooms. They are a substantial, albeit mostly unexplored, source of novel, potent pharmaceuticals. Specifically, and perhaps most significantly for contemporary medicine, MMs offer an infinite supply of polysaccharides (particularly β-glucans) and polysaccharide–protein complexes with immune-stimulating and anticancer effects. Numerous kinds of physiologically active high-molecular-weight and low-molecular-weight chemicals (triterpenes, lactones, alkaloids, and other compounds) are present in fruit bodies, cultured mycelia, and cultured broth in most, if not all, upper Basidiomycetes mushrooms [7]. Fruiting bodies displaying an enormous array of pharmacological features related to human health. They have been a significant part of the human diet and are used as both food and medicine for ages. They are abundant in nutrients and bioactive substances, including carbohydrates, fibres, proteins, vitamins, and minerals. They also have a host of health benefits, including antibacterial, antiviral, antioxidant, anticancerous, and hypocholesterolaemia properties [8]. Humans have used mushrooms for food and medicinal for a very long time. According to data from the literature, mushrooms started to become more essential in the human diet when hunting became popular. Certain filamentous fungi include edible components called fruiting bodies, which are the visible portion above the substrate that is usually referred to as the mushroom. Along with the kingdoms of prokaryotes, eukaryotes, plants, and animals, fungi also form their own kingdom. There are between 2.2 and 3.8 million known species of fungi worldwide, of which 150,000 have been named, 2000 are thought to be edible, and more than 200 species of wild mushrooms are thought to have therapeutic properties [9].

These days, MMs are used for the following purposes:

A. Dietary food (the world produced 30 million tons of mushrooms.
B. Dietary supplement products (the market for MM DS products is rapidly expanding and is valued at over 18 billion US dollars annually a novel class of pharmaceuticals known as "mushroom pharmaceuticals.
C. Natural biocontrol agents that have insecticidal, fungal, bactericidal, herbicidal, nematocidal, and antiphytoviral properties for plant protection.
D. Cosmeceuticals, which are various MM compounds, such as polysaccharides like soluble β-glucans, glucuronoxylomannan (GXM), sacchachitin, tyrosinase, and other enzymes, which are utilized by cosmetic companies for their film-forming properties, activation of epidermal growth factor, antioxidative, antibacterial, and anti-inflammatory properties, stimulation of collagen activity, prevention of autoimmune vitiligo, and treatment of acne [7].

1. **Anti-Oxidant**:

Chemical substances called antioxidants shield cells from the harm that unstable chemicals called free radicals. Strong oxidants, or free radicals, are those molecules with one or more unpaired electrons. They are involved in mutations and malignancies and have the ability to arbitrarily damage all bodily components, including lipids, proteins, DNA, and carbohydrates. Enzymes such as glutathione peroxidase, catalase, and superoxide dismutase trap the emerging oxygen. Oxidative stress is caused by an excessive amount of free radical generation. Mushrooms are a strong source of antioxidants, which are an essential part of the body's defense against free radicals. Extracts from waxy cap mushrooms (Hygrocybe coccinea) have been shown to prevent sarcoma growth. Animal studies have demonstrated the anticancer effects of immuneoceticals extracted from over thirty different types of mushrooms. Head and neck cancer can be prevented using Schizophyllan from Schizophyllum commune. The substances' antioxidant properties are associated with their phenolic constituents. The extracts from mushrooms have the ability to preserve DNA. Many tree radicals can be captured by G. lucidum extract, which is linked to the antioxidant qualities of certain ear mushrooms. Numerous mushroom species have demonstrated strong immune-enhancing properties, boosting both human and animal immunity against cancer. Antioxidant tyrosinase is derived from antioxidant activity. The primary chemical components found in G. lucidium are triterpenoides. In G. lucidum, camptothecin is the source of its antioxidant qualities [2].

2. **Anti-Microbial:**

The investigated in the treatment of drug-resistant isolates of Streptococcus, Enterococcus, Eschrichia coli, and Staphylococcus epidermidisas well as species of Candida, Streptococcus, and S. aureus. The growth of Bacillus megaterium, S. aureus, E. coli, Klebsiella pneumoniae, Candida albicans, Candida glabrata, species of Trichophyton, and Epidermophyton were all inhibited to varying degrees by methanolic extracts of Pleurotus species, and this inhibition was lower when compared to two antifungal agents: streptomycin and nystatin. The kind of solvent used determined the antimicrobial and antifungal activity of ether extract was more effective against Gram-negative bacteria than acetone extract [10]. Staphilococcus aureus, Escherichia coli, Klebsiella pneumoniae, Pseudomonas aeruginosa, and Enterococcus faecalis were the microorganisms utilized as test organisms in this study. The American Type Culture Collection is where all of the microorganisms used were obtained [14].

3. **Anti-Cancer:**

Anticancer properties mushrooms contain compounds that inhibit tumour activity, although very few of these have been tested in humans. Prostate and breast cancer can be avoided by eating edible mushrooms

in all their forms, particularly white button mushrooms especially. Fresh mushrooms have the ability to stop the growth of malignant tumours by inhibiting the activity of substances called 5-alpha-reductase and aromatase. One of the most popular drugs for cancer treatment, Polysaccharide-K (Kresin), is obtained from Trametes versicolor. Certain polysaccharides derived from mushrooms also have the power to lessen the negative effects of chemotherapy and radiation. In mushrooms such as Lentinula edodes, Tramtes versicolor, Agaricus bisporous, and others, these effects have been clinically proven.[11] Certain medicinal mushrooms show promising anti-cancer capabilities, such as Hericium erinaceus, Trametes versicolor, Grifola frondose, Cordyceps militaris, Schizophyllum commune, etc. The compounds found in these mushrooms have the potential to modulate the immune system, thereby enhancing its efficacy in combating cancer cells and improving overall cancer treatment outcomes. This provides patients with a multimodal approach to managing the intricacies of their cancer disease.[12] It has long been recognized that certain mushrooms with a higher Basidiomycetes origin have anti-cancer properties. The used extracts from the fruiting bodies of and other homobasidiomycetes in experiments against the Sarco-ma 180 line in mice to show the anticancer activity of the higher Basidiomycetes. Calvacin, a naturally occurring product extracted from the medicinal mushroom, was widely employed as an anticancer agent in numerous laboratories throughout the 1960s and was the most often referenced natural product. The isolated calvacin from the gigantic puffball Calvatia (Langermannia) gigantea Lloyd, and the compound shown efficacy against a variety of experimental cancers, such as Sarcoma 180, mammary adenocarcinoma 755, leukemia L-1210, and HeLa cell lines. It has been discovered that over 650 species of higher Basidiomycetes have anticancer action. It is now very important to look for novel anticancer and other therapeutic compounds in mushrooms and research the medicinal benefits of these plants [15].

4. Anti-Fungal:

Antifungals are compounds that either eradicate or prevent the growth of the spores or fungus that cause an infection [16]. Mushrooms show the antifungal activity are wild, there is greater variation among the species under study. It is difficult to obtain the various particular conditions needed for mushroom growing. A number of elements, including physiological and environmental ones, as well as the presence of plagues, affect the cultivation of mushrooms. While each species has a unique response, claim that all mushrooms' phenotypes are influenced by the soil. A notable illustration of this is the soil humidity, which can either postpone (Cortinarius caperatus and Catathelasma ventricosum) or encourage (e.g., Boletus edulis and Lactarius deterrimus) the first fructification period. Moreover, it has been noted that the growth of mushrooms is hampered by the presence of insects, mites, crustaceans, and other arthropods that break down wood or synthetic substrates used in mushroom cultivation [10]. Additional research indicates that shiitake mushrooms (Lentinus edodes) grow larger and produce more when grown on substrates enriched with sodium carbonate precipitate ($CaCO_3$). As a result of the aforementioned issues, only a small number of species are farmed; so, gathering mushrooms from their native habitats is the most effective method to obtain a large diversity of mushrooms [15].

5. anti-Inflammatory:

The well-known anti-inflammatory properties of extracted ethanol from M. esculents cultivated mycelium make it significant, but only when used in dosages equivalent to those of regular Diclofenac, it can reduce both acute and chronic inflammation in mice models. Mice produced acute and chronic inflammatory models induced by formalin and carrageenan demonstrate the anti-inflammatory properties of ethyl acetate and methanolic extracts from G. lucidum. Significant anti-inflammatory activity can be obtained from G. lucidum through the extraction of chloroform[17]. Anti-inflammatory qualities a number of health issues, including cancer and heart disease, have been linked to chronic inflammation. Medicinal mushrooms with notable anti-inflammatory qualities include cordyceps (Cordyceps militaris) and maitake (Grifola frondosa). These mushrooms have demonstrated potential in reducing inflammation, which may have consequences for the therapy and prevention of a number of inflammatory diseases. The investigation of these natural therapies is indicative of an increasing interest in complementary and alternative medicine due to the possible benefits of these methods in addressing chronic inflammation-related health concerns [1]. A rising number of chronic diseases, including diabetes, obesity,

atherosclerosis, neurological diseases, and various cancer types, are linked to inflammation. While NSAIDs and steroidal anti-inflammatory medicines (NSAIDs) are commonly utilized to treat acute inflammation, their efficacy in treating chronic inflammatory illnesses has been somewhat limited, and they come with unwanted side effects. Finding novel and safer anti-inflammatory chemicals is therefore of tremendous interest. Plant extracts have been utilized in traditional medicine to treat a wide range of conditions, including both acute and chronic inflammation. Researchers have been working very hard over the past few years to identify natural compounds that may be employed as anti-inflammatory medicines [18].

6. Anti-Viral:

Antiviral: Due to their immune-stimulatory properties, Pleurotus mushrooms contain chemicals that have direct or indirect antiviral effects. The fruiting body of oyster mushrooms yielded ubiquitin, an antiviral protein that was discovered and characterized. Water-soluble sulphated derivatives of the water-insoluble $-glucans derived from P. tuberculum sclerotia were effective against herpes simplex virus types 1 and 2. The antiviral action resulted from sulphated $-glucans attaching to virus particles and stopping the infection of host cells. Polysaccharides with immunomodulatory properties are present in P. ostreatus's extracellular extract in addition to its intracellular proteins [3]. Viruses of Herpes Simplex the Herpes Simplex Virus (HSV) is a member of the Herpesviridae family of enveloped double-stranded DNA viruses. HSV-1 and HSV-2 are the two serotypes that make up HSV. While HSV-2 is linked to vaginal infection, neonatal herpes, and herpetic paronychia, HSV-1 can cause gingivostomatitis, herpes labialis, encephalitis, herpes keratitis, and genital herpes. The viral genome splits into immediate early (IE or a), early (E or ß), and late (L or y) genes, and it encodes over 80 distinct proteins. IE proteins are directly translated from IE genes. IE proteins are transcriptional regulators that are necessary for the transcription of the E and L genes. These proteins include ICPO, ICP4, and ICP27. The E genes produce the proteins that are in charge of protein modification (US3), viral replication (UL5, UL30, and UL42), and nucleotide and DNA metabolism (UL2, UL12, UL23, UL40, and UL50). Viral structural proteins including glycoprotein and capsid protein are translated from L genes like UL10, UL18, UL27, and US4 [7,42]. The available antiviral medications against HSV are analogs of nucleosides, such as valacyclovir, acyclovir and famciclovir trifluridine with penciclovir. Among the most widely used anti- HSV medication for vaginal and labial herpes. Viral phosphorylation occurs in it. cellular kinases and thymidine kinase and is integrated into the DNA of viruses, it prevents the spread of viruses by DNA polymerase from HSV [19].

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